PATENT SPECIFICATION

1,057,752

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Date of Application and filing Complete Specification: April 14, 1964. *No. 15377/64*

Application made in Germany (No. 09371v/84d) on April 24, 1963.

Complete Specification Published: February 8, 1967.

Index at Acceptance:—**E1** F22; **F1** P (6H, 6K, 7C, 10X).

Int. Cl.:—**E 02 f 9/22** // F03c.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Control System for Hydraulically Operated Equipment such as Excavators

WE. ORENSTEIN-KOPPEL UND LUBECKER MASCHINENBAU AKTIENGESELLSCHAFT, a German Company of Tempelhofer Ufer 23/24 Berlin SW 61, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

The present invention relates to a control system for hydraulically operated equipment, such as a hydraulic excavator, having at least two working circuits, and wherein an adjustable hydraulic pump is provided in each working circuit.

Control systems are known in which, for example, a traversing gear, a slewing gear and an excavator arm actuator are associated in one hydraulic circuit with one adjustable hydraulic pump and the other working circuit with its adjustable hydraulic pump includes the other traversing gear, the bucket actuator and the jib actuator.

Such known control systems are arranged so that the pumps supplying the actuators which are not operative in each case transfer their pressure fluid to a selected actuator which is in operation and which is considered to be the main working actuator. In hydraulic crane drives this is for example the drive mechanism for the hoisting gear, so that an increase in capacity can be obtained for the machine by raising the hoisting speed. In excavators, especially when used as deep bucket excavators, in order that the full motor capacity shall be available for the excavating operation, two working circuits have been connected together so that the whole of the pressure fluid from both working circuits acts on the piston of the excavator arm actuator.

A disadvantage of these known arrangements is that the full drive capacity could only be utilised for one selected operation which according to the interpretation of the manufacturer was regarded as the main working operation requiring an increase in capacity of the apparatus in question.

It is an object of the present invention to enable this known method of increasing the capacity of a hydraulic excavator to be extended as far as is possible to include more than one individual operation of the excavator.

In the interests of smooth operating of an excavator, it is necessary for at least two, and possibly more, operations to be carried out simultaneously. On the other hand among the various operations performed by such an excavator, not only the digging operation but also the lifting of the material can be considered as main operations where an increase in capacity would be of advantage. Both operations, the digging process and the lifting movement, generally take place separately and during this time no other operation is usually necessary. It is therefore desirable to be able to effect the digging and lifting operations individually with the full capacity of the motor, although at other times it may be desired to energise both the digging and lifting actuators simultaneously, each absorbing only a part of the full motor capacity.

The invention consists broadly in a control system for hydraulically operated equipment, such as an excavator, comprising two hydraulic circuits each including a variable stroke hydraulic pump, and a control valve for controlling the supply of hydraulic fluid to a hydraulic actuator associated with the valve, the pressure conduit of each circuit communicating through the respective control valve with a common pressure connection, which has branch connections through non-return valves to the pressure conduits of the

[Price 4s. 6d.]

two circuits, and which is also connected to a return line leading through the same two control valves, such that pressure fluid can be supplied simultaneously from both pumps to either one of the two actuators, or each actuator can be supplied with pressure fluid from its associated pump alone.

In a preferred construction the two control valves are eight-way three-position spool valves, which in their neutral positions open the return line and connect the pressure conduits of the two circuits to the common pressure connection, while when either valve is moved out of its neutral position it closes the return line and shuts off the common pressure connection.

By using a control system according to the invention considerable digging power is made available. The digging operation can continue with increased power and reduced speed if an excavator which operates with a rigid transmission is already immobile. Full utilisation of the maximum power is obtained for two operations so that the disadvantages of series connections are avoided, such as arises for example with a drag-line excavator if several couplings are operated simultaneously. The full motor capacity necessarily comes into effect during the digging and hoisting operations independently of the load and of the excavator operator's method of working.

The sole figure of the accompanying drawing illustrates diagrammatically a control system according to the invention for a hydraulic excavator. In the hydraulic control system illustrated, two working circuits are provided for the oil flow. Two adjustable capacity hydraulic pumps 1, 2 of equal size are each associated with a working circuit. They are arranged so that they absorb the full motor capacity when both circuits are activated simultaneously.

One working circuit includes the adjustable hydraulic pump 1, a traversing drive 3 for the right side of the hydraulic excavator, a double acting working cylinder 4 for a bucket, a double acting working cylinder 5 for a jib, and control valves 6, 7, and 8. The control valve 8 connected to the cylinder 5 is an eight-way three-position valve, and valves 6 and 7 are six-way three-position valves.

The working circuit of the adjustable hydraulic pump 2 includes a traversing drive 9 for the left side of the hydraulic excavator, a slewing drive 10 for the slewing mechanism and a double acting working cylinder 11 for the excavator arm carrying out the digging operation. Control valves 12, 13 and 14 serve to control this working circuit and the control valve 14 connected to the working cylinder 11 is again an eight-way three-position valve, the valves 12 and 13 being six-way three-position valves.

The four valves 6, 7, 12 and 13, are so arranged that in their central positions they each maintain the pressure line of the respective hydraulic circuit open to the next following valve. The two valves 8 and 14 which control the rams 5 and 11 have a common pressure connection 20 which communicates with one or both of the pump outputs when the valve or valves are in their central positions. From this connection 20 extend two branch connections 21, 22, each including a non-return valve 15, 19, and leading respectively to the high pressure inlet side of each valve 14 or 8.

The common pressure connection 20 also communicates with a common return line 23 which passes through both valves 8 and 14 when in their central neutral positions, and leads back to a reservoir 24. When either valve 8 or 14 is moved out of its central position into one of its operating positions the return line 23 and the input through the valve to the pressure connection 2, are closed.

If the full drive capacity is required to act on the piston of the working cylinder 11 for the digging operation, the control valves 6, 7, 8, 12 and 13 are moved to their central neutral positions, whilst the control valve 14 is moved to whichever control position is required, that is to say either up or down or into its central neutral position as shown. Thus the oil from the working circuit of the adjustable hydraulic pump 2 flows directly to the control valve 14, and the oil from the working circuit of the adjustable hydraulic pump 1 flows through the three valves 6, 7, and 8, opens the non-return valve 15 and then flows to the control valve 14. Thus both pumps 1 and 2 simultaneously deliver oil to the cylinder 11.

For the hoisting movement of the hydraulic excavator which follows the digging operation, the control valves 6, 7, 12, 13 and 14 are moved to their central neutral positions and the control valve 8 is operated as required, that is into its up, down or central position.

In this case the oil from the working circuit of the adjustable pump 2 passes through the valve 14 into the common pressure connection 20, opens the non-return valve 19, and then joins the flow from the working circuit of the adjustable hydraulic pump 1. The oil passes to the control valve 8 through a non-return valve 16.

Thus it will be seen that the whole flow of oil from either hydraulic pump circuit can be directed into the other circuit, so that both pumps supply the same working cylinder. If both the two selected primary working cylinders 5 and 11 are inoperative, their respective control valves 8 and 14 being in their central positions, the common

pressure connection 20 is connected via the return line 23 to the reservoir 24, but this return line is closed when either valve 8 or 14 is moved out of its central position.

Since the control valves 8 and 14 are required to pass twice as much oil as the control valves 6, 7, 12, 13, they are made correspondingly larger.

A further non-return valve 17 is inserted between the control valve 8 and the working cylinder 5 and operates in conjunction with a throttle 18 to provide a throttle/non-return valve combination.

WHAT WE CLAIM IS :—

1. A control system for hydraulically operated equipment, such as an excavator, comprising two hydraulic circuits each including a variable stroke hydraulic pump, and a control valve for controlling the supply of hydraulic fluid to a hydraulic actuator associated with the valve, the pressure conduit of each circuit communicating through the respective control valve with a common pressure connection, which has branch connections through non-return valves to the pressure conduits of the two circuits, and which is also connected to a return line leading through the same two control valves, such that pressure fluid can be supplied simultaneously from both pumps to either one of the two actuators, or each actuator can be supplied with pressure fluid from its associated pump alone.

2. A control system as claimed in claim 1, in which the two control valves are eight-way three-position spool valves, which in their neutral positions open the return line and connect the pressure conduits of the two circuits to the common pressure connection, while when either valve is moved out of its neutral position it closes the return line and shuts off the common pressure connection.

3. A control system as claimed in claim 1 or claim 2, including one or more additional control valves in one or both hydraulic circuits, each controlling the flow of pressure fluid to an associated actuator.

4. A control system for a hydraulically operated excavator, substantially as described with reference to the accompanying drawings.

5. A hydraulically operated excavator including a control system in accordance with any one of the preceding claims.

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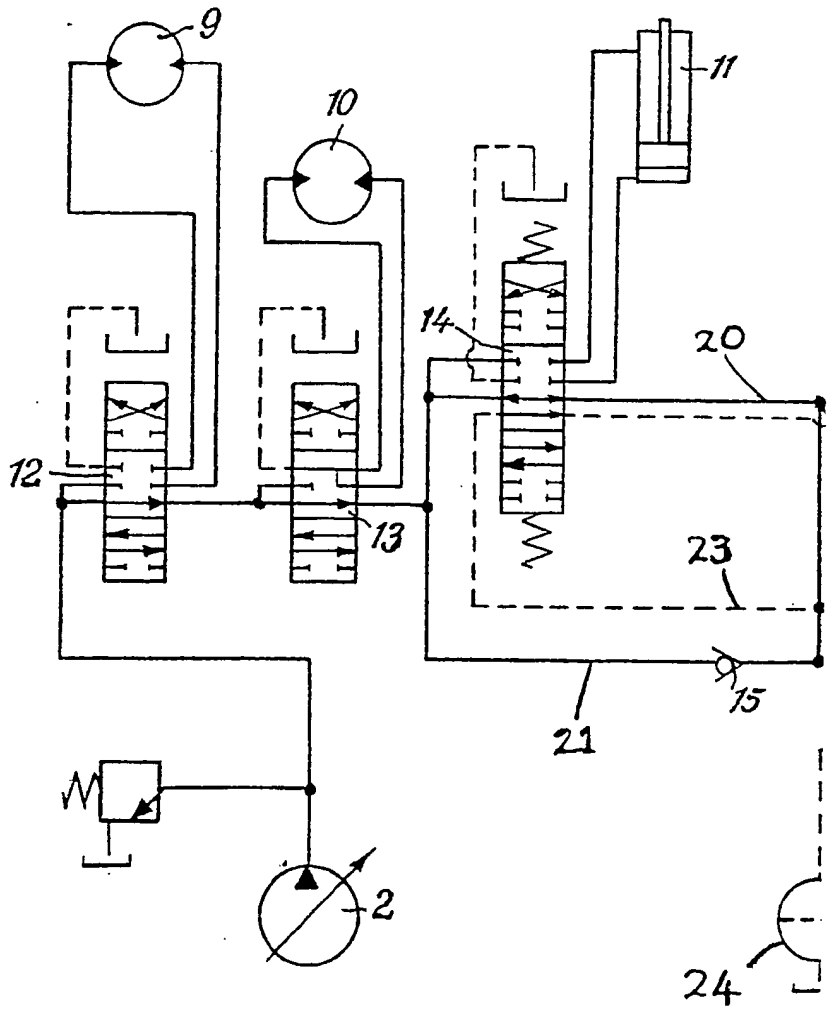
Berwick-upon-Tweed: Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd.—1967
Published at the Patent Office, 25 Southampton Buildings, London, W.C.2 from which copies may be obtained.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1,057,752 COMPLETE SPECIFICATION
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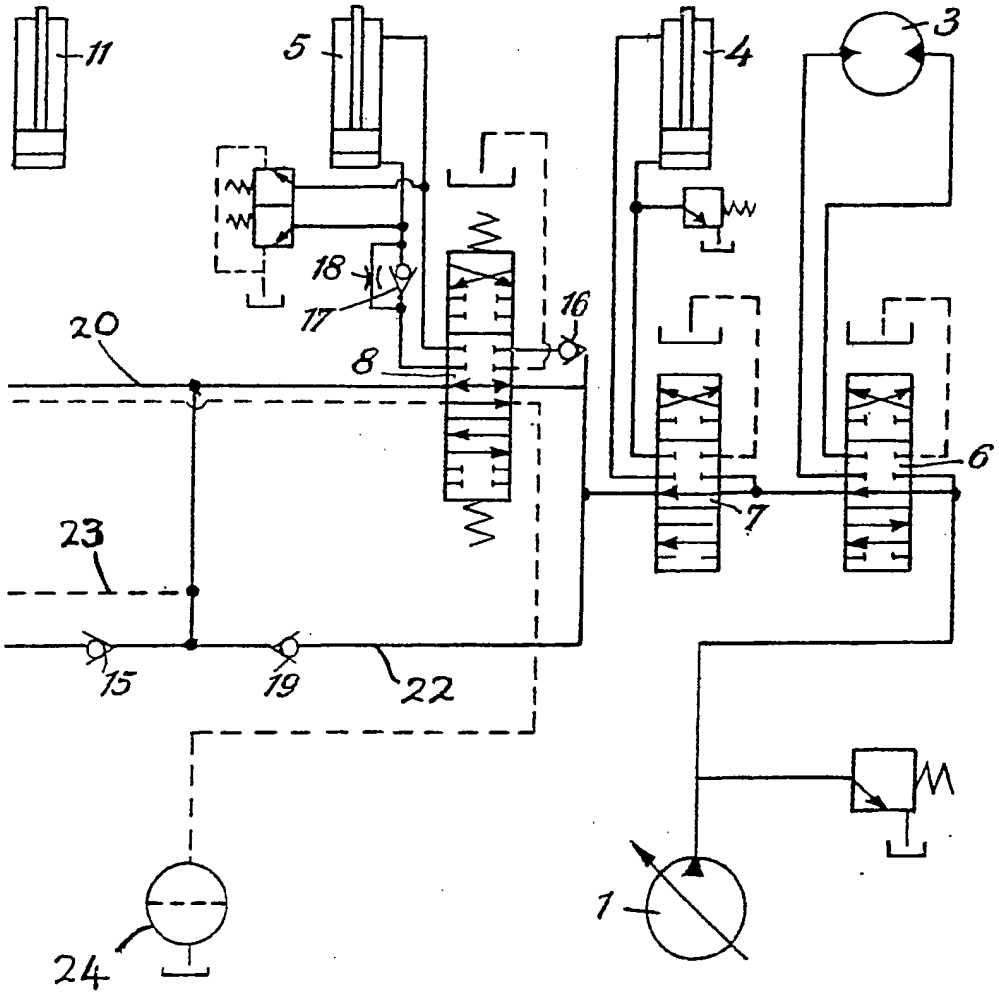

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